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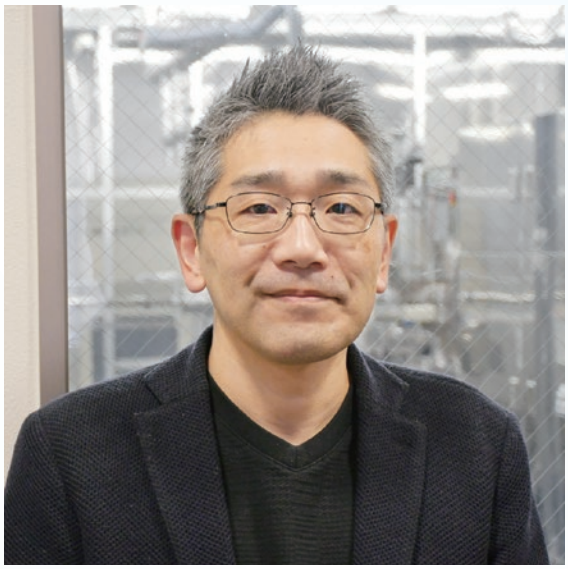
An elegant Kyoto spring scene featuring Tatsumi Bridge viewed from Gion Shirakawa street

The view of Gion Shinbashi Street with the stone-paved Tatsumi Bridge is one of the most popular spots in Kyoto. Because of its distinctive beauty —iron-red house lattices, the vermilion architecture of Tatsumi Shrine, and maiko and geiko gliding along the street—it is often featured as a setting in dramas and movies. The area surrounding the site dates back to the Edo period and is designated as a historic preservation district. Seeing Gion in its charming spring mode, enhanced by several varieties of cherry blossoms, is a once-in-a-lifetime sight.

Professor Mikihiko Oogane

Professor, Department of Applied Physics, Graduate School of Engineering, Tohoku University

For this interview, we visited Tohoku University's Aobayama Campus to speak with Professor Mikihiko Oogane about his research on high-sensitivity magnetic sensing and magnetic materials based on quantum spintronics technology.



Brief History

1994	Entered the School of Engineering, Tohoku University
1997	Joined the laboratory of Professor Terunobu Miyazaki, Department of Applied Physics, Tohoku University
2003	Ph.D. in Engineering, Graduate School of Engineering, Tohoku University
2004	Research Associate, Graduate School of Engineering, Tohoku University
2007	Assistant Professor, Graduate School of Engineering, Tohoku University
2010	Associate Professor, Graduate School of Engineering, Tohoku University
Apr.2022-Present	Professor, Graduate School of Engineering, Tohoku University

"Under the motto "Seeing the brain through spin," we are working toward the realization of a brain–information interface that can be used by anyone, anytime, anywhere—an essential platform for the next digital revolution."

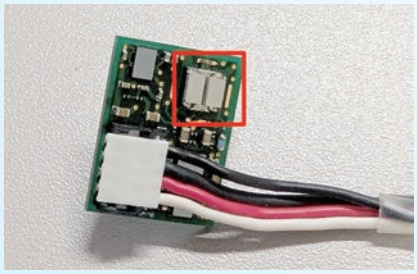
▶Please tell us about your current research.

Our laboratory aims to create groundbreaking materials and devices by leveraging quantum spintronics technology. Under the motto "Seeing the brain through spin," we are working toward the realization of a brain–information interface that can be used by anyone, anytime, anywhere—an essential platform for the next digital revolution. At the center of my current research is the development of ultra-high-sensitivity magnetic sensors based on the quantum tunnel magnetoresistance effect, commonly known as TMR (Tunnel Magnetoresistance).

The TMR effect occurs in a structure where an extremely thin insulating layer, on the order of nanometers, is sandwiched between two ferromagnetic layers. Depending on whether the magnetizations of these layers are aligned parallel or antiparallel, the electrical resistance of the device changes significantly. The resistance is low when the magnetizations are parallel and high when antiparallel. By utilizing this property, it becomes possible to detect extremely weak magnetic fields. The TMR sensors we have developed integrate this function into a small silver-colored chip, approximately 3 mm on each side. Because of their high sensitivity, they respond even to subtle magnetic fields generated by devices such as smartphones or cameras.

We are accelerating efforts to apply this technology in the medical field, particularly in magnetocardiography (MCG), which measures magnetic fields generated by the heart, and magnetoencephalography (MEG), which measures magnetic fields produced by brain activity. Magnetic signals emitted by the human body are extraordinarily weak. While the Earth's magnetic field is approximately 50 microtesla, biological magnetic signals are more than one million times smaller, and in some cases reach the picotesla to femtotesla range, corresponding to one hundred-millionth or even smaller fractions of the geomagnetic field.

Until now, only superconducting devices known as SQUIDs (Superconducting Quantum Interference Devices) have been capable of detecting signals at this level. However, SQUID systems require cooling to cryogenic temperatures



Actual TMR sensor. The chip highlighted in red measures approximately 3 mm × 3 mm.

Oscilloscope output waveform from the TMR sensor showing variation when a magnetic source (e.g., smartphone or camera) is brought nearby.

using liquid helium, making them large, expensive, and dependent on specialized facilities—factors that limit widespread adoption. Our goal is to achieve performance comparable to superconducting devices using TMR sensors that operate at room temperature.

A major feature of our sensors is device integration. We fabricate microscopic sensing devices, too small to see individually, and connect them in arrays of 100, 1,000, or even 10,000 devices within a single chip. This approach follows the principle of statistical averaging: increasing the number of devices reduces noise in proportion to the square root of the number of devices. By connecting 10,000 devices, noise can theoretically be reduced by a factor of 100, dramatically lowering the detectable magnetic field threshold. Through advanced microfabrication techniques, we have achieved world-leading sensitivity in the range of several hundred femtotesla.

Professor Oogane with the plasma CVD system "PD-100ST."

Parallel-plate RIE system "RIE-10NR," introduced in 2026.

▶What led you to this field of research?

My path into this research field was actually quite accidental. As a student at Tohoku University, I originally hoped to study optics. However, when laboratory assignments were made in my fourth year, the lab I preferred was extremely competitive, and I was not admitted. I was instead assigned, almost by process of elimination, to the laboratory of Professor Terunobu Miyazaki, who had just discovered the giant room-temperature TMR effect and was attracting worldwide attention. There, I was given TMR as my undergraduate research theme. That was the beginning of my research career.

Looking back, I could not have been more fortunate. I had the opportunity to learn under Professor Miyazaki, and later continued the research direction proposed by Professor Yasuo Ando, who advocated applying TMR to ultra-high-sensitivity magnetic sensors. I have now been engaged in this field for nearly 30 years.

The TMR effect remains scientifically fascinating, with many aspects still not fully understood from a physics standpoint. At the same time, it has demonstrated enormous engineering value, having already been implemented in hard disk drive heads. Few phenomena possess both such scientific depth and such practical impact. Even after decades, I never tire of studying it.

▶What are your thoughts on the future of this research field?

Looking ahead, under Japan's Strategic Innovation Promotion Program (SIP) running through 2027, we aim to improve sensor performance by an additional order of magnitude and achieve real-time detection at the 10 femtotesla level. If realized, this would make it possible to read brain information in real time and connect it to computers or robots—forming what is known as an Internet of Brains (IoB) system.

We are committed to non-invasive approaches, reading brain signals from outside the head without inserting electrodes. We envision creating a society in which people can move and control things as they wish across a wide range of fields: from enabling individuals with limited mobility to communicate their intentions, to applications in gaming and entertainment, and even remote industrial operations. By the 2040s, wearable devices capable of measuring brain information are expected to become commonplace. The potential impact extends far beyond medicine. It is estimated that more than one billion patients worldwide could benefit medically, and related industries may reach a scale of approximately six trillion yen.

Another major initiative is the development of ultra-compact MRI (Magnetic Resonance Imaging) systems. Conventional MRI systems are extremely large and require dedicated hospital facilities. By leveraging our high-sensitivity sensor technology, we aim to reduce MRI systems to desktop size. At the 2025 Osaka–Kansai Expo, we exhibited a tabletop "Spin-MRI" system capable of monitoring a hand- or foot-sized region in approximately one minute. Future applications may include installation in ambulances, home use, and even food inspection. While spatial resolution does not yet match that of large-scale systems, the ability to perform immediate diagnosis at the point of need offers substantial value for the future of healthcare.

"After introducing the plasma CVD system "PD-100ST," we have been able to form high-quality SiO_2 films with excellent stability, and device yield has improved dramatically."

▶You've used several of Samco's systems in your lab. Could you share your experience?

Samco's equipment plays an essential role in our research processes. Our devices are constructed by stacking multiple nanometer-scale ultra-thin films. The reliability of these structures depends heavily on the formation of high-quality interlayer SiO_2 insulating films. Previously, we relied entirely on sputtering, but this resulted in insufficient insulation and short-circuit defects. After introducing the plasma CVD system "PD-100ST," we have been able to form high-quality SiO_2 films with excellent stability, and device yield has improved dramatically. The elimination of short-circuit defects has enabled us to reliably integrate as many as 10,000 devices.

More recently, we introduced the parallel-plate RIE system "RIE-10NR" for opening contact holes between electrodes and sensing devices. To reduce sensor noise, impurity-free metal contact is essential, which requires completely removing insulating films deposited by CVD. We expect the RIE-10NR to fulfill this role.

Samco's systems are highly reliable, with minimal breakdowns and stable process conditions. For a laboratory like ours, where meticulous experiments are repeated daily, this reliability is invaluable. From a manufacturer's perspective, maintenance services may be part of the business model, but from a user's perspective, durability is the greatest value. Samco's equipment supports our research from the ground up through its stability and reliability.

▶What do you keep in mind in your research?

I constantly strive to avoid falling into a rut. After working on the same theme for 30 years, it is easy for ideas to become fixed. To continue progressing, we must continuously incorporate new technologies and perspectives from other fields.

Regarding student guidance, I respect their autonomy above all else. The students who come to Tohoku University are exceptionally talented. When faculty avoid unnecessary interference, they grow freely and often at remarkable speed. In my laboratory, students are encouraged to propose their own research themes and make their own decisions. The fact that many doctoral students choose to join my lab may reflect their enjoyment of identifying and solving problems independently.

▶How do you spend your days off?

Since I immerse myself in research during the week, I make a point to refresh myself on weekends. Lately, I have been going to the pool with my kids. Swimming, which exercises the whole body, is very beneficial for maintaining health, and in the water, I can forget about research and clear my mind. I also value relaxing time spent watching international TV dramas on streaming services. I do not have a particularly distinctive hobby, but maintaining a clear distinction between work and rest is, I believe, the key to sustaining a long research career.

If I had to name one interest, it would be exploring the roots of things. I frequently read books on Japanese history, especially the ancient period surrounding the formation of the Yamato court, which still contains many mysteries. Tracing how this country was formed and considering the origins of its culture provides an absorbing and refreshing intellectual escape.

▶Do you have any final thoughts?

I see Samco as a reliable manufacturer that clearly defines its areas of technical expertise and consistently delivers high-quality products within those domains. We, too, steadily build our technology step by step, pursuing diligent research—what I sometimes refer to as an "agricultural" mindset. I sense a similar spirit in your approach to manufacturing.

Samco's sales representatives don't just visit when we have a budget; they make frequent, regular visits, showing genuine concern for the condition of our equipment and any issues we face. This sincere approach builds significant trust and reassurance when we consider introducing new equipment. While technical capability is essential, we also deeply value this trust-based relationship. I hope Samco will continue to provide durable equipment that researchers can rely on with confidence, and maintain long-term support even for older systems.

Thank you for taking the time to speak with us despite your busy schedule.

Interview conducted:
January 27, 2026

"I hope Samco will continue to provide durable equipment that researchers can rely on with confidence, and maintain long-term support even for older systems."

Café and Coffee Shop Tours in Kyoto #4

Locals often say, “Morning in Kyoto starts with the aroma of Inoda coffee.” True to this phrase, Inoda Coffee is an iconic Kyoto traditional coffee shop. In this issue, we will reveal the origins of how the chain began and how it is maintained today, as told to us by the company’s three key figures, with a focus on its original flagship store, in central Kyoto.

*** Prices in this article include tax**

Set menu “Kyoto Breakfast,” including boneless ham, salad, scrambled eggs, and a croissant, served with a mini orange juice and hot coffee.

The shop’s uniqueness starts with how it pronounces “coffee” in Japanese. The founder, Shichiro Inoda, insisted on reading “koh-he” (short e vowel) instead of “koh-hee,” based on how the word was originally pronounced in Japan. The red coffee pot trademark logo also remains the unchanged. The chain’s traditional coffee taste continues to suffuse the six Kyoto locations (including the flagship shop), as well as in Tokyo, Kanagawa, and Hiroshima, and its online distribution.

At seven a.m., the shop opens, filling the air with the aroma of its hallmark blend, “Arabian Pearl,” served since Inoda Coffee’s founding. The Mocha-based blend is carefully prepared in a deep-roasted European style, conveying a delicate balance of aroma, richness, and acidity. The coffee is brewed using the traditional nel-drip method, another consistent pursuit of the shop.

“You’ll never find a coffee so deep and rich as this Arabian Pearl,” Kikuyo Shimada, the shop’s executive operations manager, strongly affirms.

The original shop has been restored to the south of the current townhouse-style building. Dubbed the “Memory House,” it displays items from Inoda’s history, including photos of notable regulars who were contemporary novelists and celebrities.

The founder himself was an artist. At age 24, in 1940, he began importing coffee beans from abroad, but closed his business when he was conscripted for military service. After the war, he returned to Kyoto and opened a small café in 1947. Yasuko Kaku, the chief planner/public relations officer, explains: “We have heard that the coffee beans in storage were in perfect condition, which was a stroke of luck for him.”

Coffee was a luxury item when the shop opened. While other shops offered ersatz coffee, Inoda served the real thing for the same price, gaining popularity among nearby kimono merchants and cultural figures.

In 1953, an inner seating area was added, now known as the “Old Wing,” still used and loved today for its serene, nostalgic atmosphere. In 1967, the main building was expanded to the north, featuring a lattice-style exterior and a bright European-style interior, along with a west-facing terrace.

After the main building was destroyed by fire in 1999, it was rebuilt and reopened in 2000. While incorporating reinforced concrete, the design preserves a wooden texture that blends with the surrounding streetscape. The café offers 211 seats (156 on the first floor, 55 on the second), allowing customers to enjoy Kyoto-style coffee in different atmospheres.

The founder was also a step ahead in menu development. He led the industry by introducing Western-style items such as sandwiches, spaghetti, and French toast. Inoda’s high-quality food, developed through long experience, meets the ever-growing expectations of many discerning palates.

One of its signature items is the “Kyoto Breakfast” (1,890 yen). Reminiscent of a luxury hotel breakfast, it includes boneless ham from a famous Chigasaki smokehouse, fresh vegetable salad, fluffy scrambled eggs, and a rich buttery croissant. The menu is diverse, and the “Clubhouse Sandwich” (1,880 yen) has been recently renewed as a more luxurious offering.

Club sandwich only available at the flagship shop

A different kind of blend promoted by Inoda is that of digital technology (implemented in sales / purchase transactions in 2023) and non-digital operations (such as a dedication to hospitality). Ryoichi Yomo, the flagship shop manager, insists that Kyoto-style hospitality must be passed down to the next generation, despite changes (e.g., a change in its parent company in 2025).

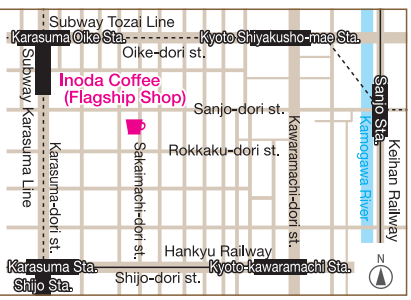
The aroma of Inoda Coffee fills the air, marking the start of another morning in Kyoto.

Manager Ryoichi Yomo

Inoda Coffee (Flagship Shop)

140 Doyu-cho, Sakaimachi Street,
Sanjo Sagaru, Nakagyo-ku, Kyoto City
TEL: 075-221-0507
Website: https://www.inoda-coffee.co.jp/

- Hours: 7:00 a.m. to 6:00 p.m.
  (last order: 5:30 p.m.)
- Open year-round
- Approx. 5-minute walk from Karasuma Oike Station, Kyoto Municipal Subway / 10-minute walk from Karasuma Station, Hankyu Railway / 15-minute walk from Sanjo Station, Keihan Railway



Introduction to the Dual-Chamber ALD System “AD-8002LPC”

Introduction

With the miniaturization and increasing functionality of semiconductor devices, the importance of Atomic Layer Deposition (ALD)—which enables nanoscale film thickness control and excellent coverage—is growing[1]. Among the types of films deposited by ALD, insulating oxide films such as AlO_2 and SiO_2 were among the first to be adopted in mass production processes and play a crucial role in manufacturing applications. Meanwhile, demand is also growing for a diverse range of film types, including nitride films, films containing heavy metals, and conductive films. As shown in Table 1, Samco is actively pursuing development in these areas as well[2,3]. This report introduces the dual-chamber ALD system “AD-8002LPC.”

System Specifications

The AD-8002LPC is equipped with two reaction chambers, based on Samco’s well-established ALD system, the “AD-800LP.” Figure 1 shows the exterior of the system. This system is equipped with a vacuum cassette chamber and supports both direct wafer handling and tray transfer.

For production applications, processing the same film type simultaneously in both reaction chambers reduces the takt time per cassette, as shown in Table 2. For research applications, depositing different film types in each reaction chamber helps minimize contamination. Additionally, the system enables the deposition of multilayer films with different deposition temperatures, a feat difficult to achieve with a single reaction chamber. In addition, by selecting appropriate precursors, the system supports deposition of a wide variety of oxide and nitride films.

Performance and Deposition Data

Figure 2 shows the deposition results obtained using the AD-8002LPC. Using 8-inch Si wafers, TiOx was deposited by thermal ALD in each reaction chamber for three consecutive batches. TDMAT (tetrakis(dimethylamino)titanium) was used as the precursor, and H_2O was used as the oxidant. In both reaction chambers, the uniformity and GPC (Growth Per Cycle; deposition amount per cycle) during the three consecutive batches were confirmed to be highly stable.

Table 1. ALD deposition materials

Oxide film				Nitride film			
	Thermal		Plasma				
	H_2O	O_3	O_2		N_2	NH_3	N_2/H_2
AlO_x	◎	◎	◎	AlN	◎	◎	◎
TiO_x	◎	☆	◎	TiN	—	◎	◎
SiO_2	X	◎	◎	SiN_x	◎	X	X
HfO	◎	☆	◎	HfN	—	☆	☆
ZrO	◎	☆	◎	ZrN	—	—	—
SnO	◎	◎	☆	SnN	—	☆	☆
ZnO	◎	☆	☆	ZnN	—	—	—
TaO_x	◎	☆	◎	TaN	—	☆	◎
GaO_x	☆	—	☆	GaN	—	☆	☆

◎ Proven track record
☆ Available upon request
X Unsuitable for our systems
— Little demand, rare in literature

Figure 1. ALD system AD-8002LPC

Table 2. Comparison of processing time per wafer and takt time

	AD-800LP	AD-8002LPC
Process time per wafer [min]	132	128
Takt time for 25 wafers [min]	3,330	1,670

For TiO_x deposition of 20 nm (GPC: 0.6 Å/cycle)
Processing time may vary significantly depending on film type and application

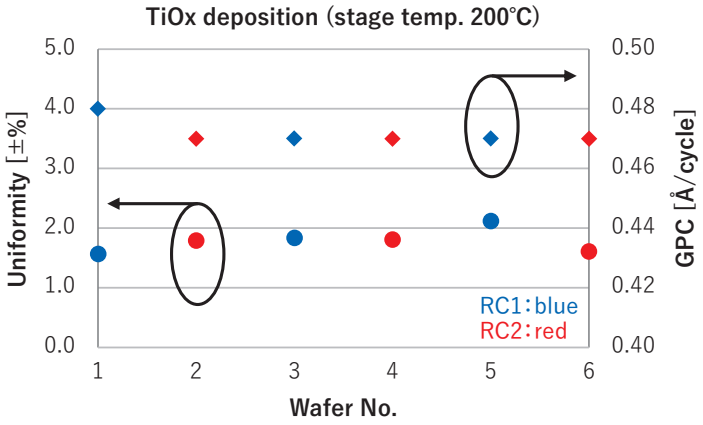


Figure 2. Results of three consecutive deposition batches in each reaction chamber of AD-8002LPC

Conclusion

In this report, we introduced the specifications of the dual-chamber ALD system “AD-8002LPC” and the basic performance of thermal ALD deposition. This system supports not only thermal ALD but also plasma ALD, and the plasma source can be selected from two types: parallel-plate and remote plasma.

Designed for a wide range of applications from research to production, the system also supports through-the-wall processing, a feature frequently required in production environments.

Going forward, we plan to expand the dual-reactor configuration to include “ALD+α” processes such as “ALD+CVD,” “ALD+ALE,” and “ALD+Aqua.”* We will continue to develop both the equipment and processes to meet customer needs.

*Aqua Plasma®: Samco’s proprietary water vapor-based plasma surface treatment process.

■ References

1. T.-Y. Lee et al., “Advances in core technologies for semiconductor manufacturing: applications and challenges of atomic layer etching, neutral beam etching and atomic layer deposition,” *Nanoscale Advances*, Vol. 7, (2025), pp. 2796–2817.
2. G. K. Deyu et al., “Recent advances in atomic layer deposition of superconducting thin films: a review,” *Materials Horizons*, Vol. 12, (2025), pp. 5594–5626.
3. Samco Inc., “Plasma enhanced and thermal ALD system AD-800LP,” *Samco Now*, Vol. 118 (July 2022).

Samco Strengthening Strategic Collaboration with ITRI, Taiwan

On February 2, 2026, Osamu Tsuji, Chairman and CEO of Samco Inc., conducted an official visit to the Industrial Technology Research Institute (ITRI) in Hsinchu, Taiwan, to facilitate strategic discussions regarding future institutional cooperation. As a world-leading research organization, ITRI is instrumental in driving semiconductor innovation and the commercialization of advanced technologies. Samco has consistently advanced semiconductor fabrication processes through global partnerships with esteemed research entities.

The discussion concentrated on emerging technical trajectories, specifically focusing on semiconductor processing, Silicon Photonics, Co-packaged Optics (CPO), and chiplet integration. Both organizations reflected on their collaborative history while exploring opportunities for joint research initiatives and bilateral personnel exchanges to enhance mutual technical capabilities.

Chairman Tsuji emphasized the significance of this engagement, noting that ITRI remains a cornerstone of global semiconductor research. He asserted that Samco's specialized equipment and processes are indispensable for the realization of next-generation Silicon Photonics and chiplet architectures. By leveraging reciprocal strengths, Samco aims to foster scientific and industrial progress within the Japan-Taiwan technological corridor.

Discussion during the visit to ITRI, Taiwan (From left: Osamu Tsuji, Chairman, Samco Inc.; Pei-Zen Chang, President, ITRI; Jwu-Sheng Hu, Executive Vice President, ITRI)

Virginia Commonwealth University EMBA Students Visit Samco

On April 17, 2026, Samco Inc. welcomed a group of Executive MBA (EMBA) students and faculty from Virginia Commonwealth University (VCU) to its Kyoto headquarters. The visit included an introduction to Samco's history and the semiconductor industry, along with a tour of its production facilities and company museum.

Chairman and Founder Dr. Osamu Tsuji delivered a lecture on management philosophy, highlighting the characteristics of Japanese and Kyoto business practices, including the importance of building long-term friendships, continuous learning, and contributing to society. The lecture concluded with an active Q&A on leadership and decision-making.

VCU EMBA students with Chairman and Founder Osamu Tsuji at Samco's Kyoto headquarters on April 17, 2026.

Over the past three years, Samco has welcomed more than 150 visitors from universities around the world. Through these engagements, the company continues to support global education and foster cross-cultural understanding of the semiconductor industry and Japanese business practices.

Samco Inc.
36 Waraya-cho, Takeda, Fushimi-ku Kyoto, 612-8443, Japan
TEL 81-75-621-7841 E-mail koho@samco.co.jp

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